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Several rarely recorded rodents from the Neogene of China

QIU Zhu-Ding

(*Institute of Vertebrate Paleontology and Paleoanthropology*, *Chinese Academy of Sciences* Beijing 100044
qiuzhuding@ivpp.ac.cn)

Abstract Numerous assemblages of fossil small mammals have been recovered from the Neogene deposits in China over the last 30 years or so. Nevertheless, some taxa in these faunas are represented by only a small number of isolated teeth from very few localities, and these are often assigned as indeterminate genus or species. Four peculiar taxa of rodents, *Sayimys sihongensis*, *Apeomys asiaticus*, *Neocometes* sp. from the Early Miocene Xiacaowan Formation of Sihong, Jiangsu Province, and *Yuneomys pusillus* from the Late Miocene Shihuiba Formation of Lufeng, Yunnan Province, are described in detail. Comparison of these specimens with similar materials from Eurasia or North America makes distinction from the known species of related genera possible, and therefore two new species (*S. sihongensis*, *A. asiaticus*) are named for the Sihong specimens, although the material is rare. A new eomyid genus *Yuneomys*, previously published under the name *Leptodontomys pusillus*, is based on specimens from Lufeng. *A. asiaticus* and *Neocometes* sp. represent the first records of the genera *Apeomys* and *Neocometes* known from Asia and China, respectively. The occurrence of the Neogene rodents in eastern China improves our knowledge of the spatial distribution of these poorly recorded animals, and contributes to a better understanding of paleobiogeographic relationships in Eurasia. Co-occurrence of the new genus with the bunodont eomyids *Plesieomys* and *Heteroeomys* in the Lufeng Fauna seems to indicate a differentiation of eomyid taxa in northern and southern faunas of China, and may reflect ecological partitioning within southeastern Asia during the Miocene.

Key words Sihong, Lufeng, Miocene, Xiacaowan Formation, Shihuiba Formation, peculiar rodents

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I dedicate this paper to Zhongjian Yang, whose pioneering investigation at Sihong, Jiangsu Province in the 1950s (see Young, 1955) has produced an important Neogene locality and rich mammalian fauna in East China, and the most taxa of the scarce rodents described.

1 Intruduction

In the last 30 years or so, the fossil record of small mammals from the Neogene in China has been expanded enormously. Collections made in Xinjiang, Gansu, Qinghai, Nei Mongol,

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Shaanxi, Shanxi, Hebei, Jiangsu, Yunnan have broadened our knowledge of systematic relationships, and the evolutionary relationships of Neogene small mammals in much of Asia (Li and Qiu, 1980; Flynn, 1997; Qiu et al., 1985, 1997; Zhang and Zheng, 2000; Zheng and Zhang, 2001; Meng et al., 2006; Qiu and Li, 2008; Wu et al., 2009; Qiu and Qiu, 2013; Cai et al., 2013; Qiu and Li, 2016). In particular, the widespread Neogene sediments with dense fossil records in central Nei Mongol produced diverse and abundant micromammalian faunas that afford an opportunity to study community structure and faunal turnovers, and to reduce ecologic or zoogeographic complications in tracing faunal succession and testing biochronological significance (Qiu and Li, 2016). Despite these remarkable advances, problems persist for a few taxa in faunas where they are poorly represented by specimens, and these are usually relegated as indeterminate genus or species.

As is commonly the case for most paleontological assemblages, taxa in known Chinese Neogene faunas are represented by different numbers of specimens, ranging from one or two isolated teeth to several hundreds. Inadequate material usually makes precise identification difficult, particularly for the unusual taxa. The purpose of this paper is to describe four peculiar genera and species, of which three were published under the name *Sayimys* sp., *Apeomys* sp. and *Neocometes* sp. from the Early Miocene of Sihong, Jiangsu (Li et al., 1983; Qiu and Qiu, 1995, 2013), and one under the name *Leptodontomys pusillus* from the Late Miocene hominoid locality of Lufeng, Yunnan (Qiu, 2006). Comparison of the Sihong taxa with Eurasian material permits recognition of these as distinct from known species of *Sayimys* and *Apeomys*; therefore two new species (*S. sihongensis* and *A. asiaticus*) are described, although both are based on limited specimens. *Neocometes* sp. is still too poorly known to characterize. "*Leptodontomys pusillus*" seems to possess distinct characters that set it apart from the genus, and therefore a new genus (*Yuneomys*) is proposed. For the geographic location and the geological background of the fossil localities, the reader is referred to Li et al. (1983) and Qi (1985).

2 Systematic paleontology

Order Rodentia Bowdich, 1821
Family Ctenodactylidae Zittel, 1893
Genus *Sayimys* Wood, 1937

Type species *Sayimys sivalensis* (Hinton, 1933).

Diagnosis See the emended diagnosis by Baskin (1996:11).

Sayimys sihongensis sp. nov.

(Fig. 1)

Sayimys sp.: Li et al., 1983, p. 317; Qiu and Qiu, 2013, p. 147

Sayimys sp.: Qiu and Qiu, 1995, p. 61

Etymology After the fossil locality, Sihong in Jiangsu Province, where the new species occurs.

Holotype Left M1 (IVPP V 23215, from Zhengji, Sihong, Jiangsu Province).

Type locality Zhengji, Sihong, Jiangsu Province.

Geological age and horizon Late Early Miocene, Shanwangian; Xiacaowan Formation.

Paratype One DP4 (IVPP V 23216, from Zhengji, Sihong, Jiangsu Province).

Referred specimen One M3 (IVPP V 23217, from Songlinzhuang, Sihong, Jiangsu Province).

Measurements DP4, 1.40 mm×1.75 mm; M1, 1.70 mm×1.75 mm; M3, 1.90 mm×2.05 mm.

Diagnosis Small species of *Sayimys*. DP4 with paraflexus and metaflexus quickly obliterated with occlusal wear, protocone being slightly internal to hypocone, paracone and metacone distinctly protrude buccally, and protoloph and metaloph being evidently longer than the anteroloph and posteroloph; M1 with quadrate outline and slightly larger hypocone than protocone, relatively transverse and straight protoloph and metaloph, developed paraflexus and metaflexus, and longer paraflexus than metaflexus, wide hypoflexus deeper than mesoflexus; M3 with short paraflexus and metaflexus, narrow, long and transverse mesoflexus.

Description The teeth are unilaterally hypsodont, with the lingual side distinctly higher than the buccal side. Crests on the occlusal surface dominate the cusps. The holotype is most probably an M1 because of its subquadrate outline of the occlusal surface and distinctly different length of paraflexus and metaflexus (indicating the length of flexi extending lingually). V 23217 from Songlinzhuang is probably an M3 because it is larger than the M1, with relatively rounded outline and subequal length of the paraflexus and metaflexus, and no sign of wear facet on its posterior side.

The DP4 is subquadrate in occlusal outline, and heavily worn. It has a robust anteroloph, a pronounced posteroloph, a marked and short endoloph, a narrow and persistent hypoflexus, and a long but shallow mesoflexus. Due to the wear, the protoloph and the metaloph are fused with the anteroloph and the posteroloph, respectively, and therefore the paraflexus and the metaflexus are obliterated. The protocone and hypocone are nearly equal in size, but the former is slightly internal to the latter. The paracone and metacone distinctly protrude buccally. The protoloph and metaloph are evidently longer than the anteroloph and posteroloph. The hypoflexus is shorter, but wider than the mesoflexus.

The M1 is nearly quadrate in outline and in a moderately worn stage. The protocone and the slightly larger hypocone are connected by a thick and straight endoloph. The paracone and metacone are distinct, but much smaller than the protocone and hypocone. The protoloph is transverse and prominent, joining the posterior margin of the protocone. The metaloph is slightly directed backwards to join the hypocone. The strong anteroloph is confluent with the anterior arm of the protocone, whereas the weakly developed posteroloph is fused with the metaloph and the posterior arm of hypocone lingually. The paraflexus and metaflexus are well developed with the former distinctly longer than the latter. The hypoflexus is wide and extends half way of the crown. The internal area of the hypoflexus is deeper than that of the mesoflexus, so it is more persistent than the paraflexus and metaflexus basins. There are three roots, a large lingual one and two small buccal ones.

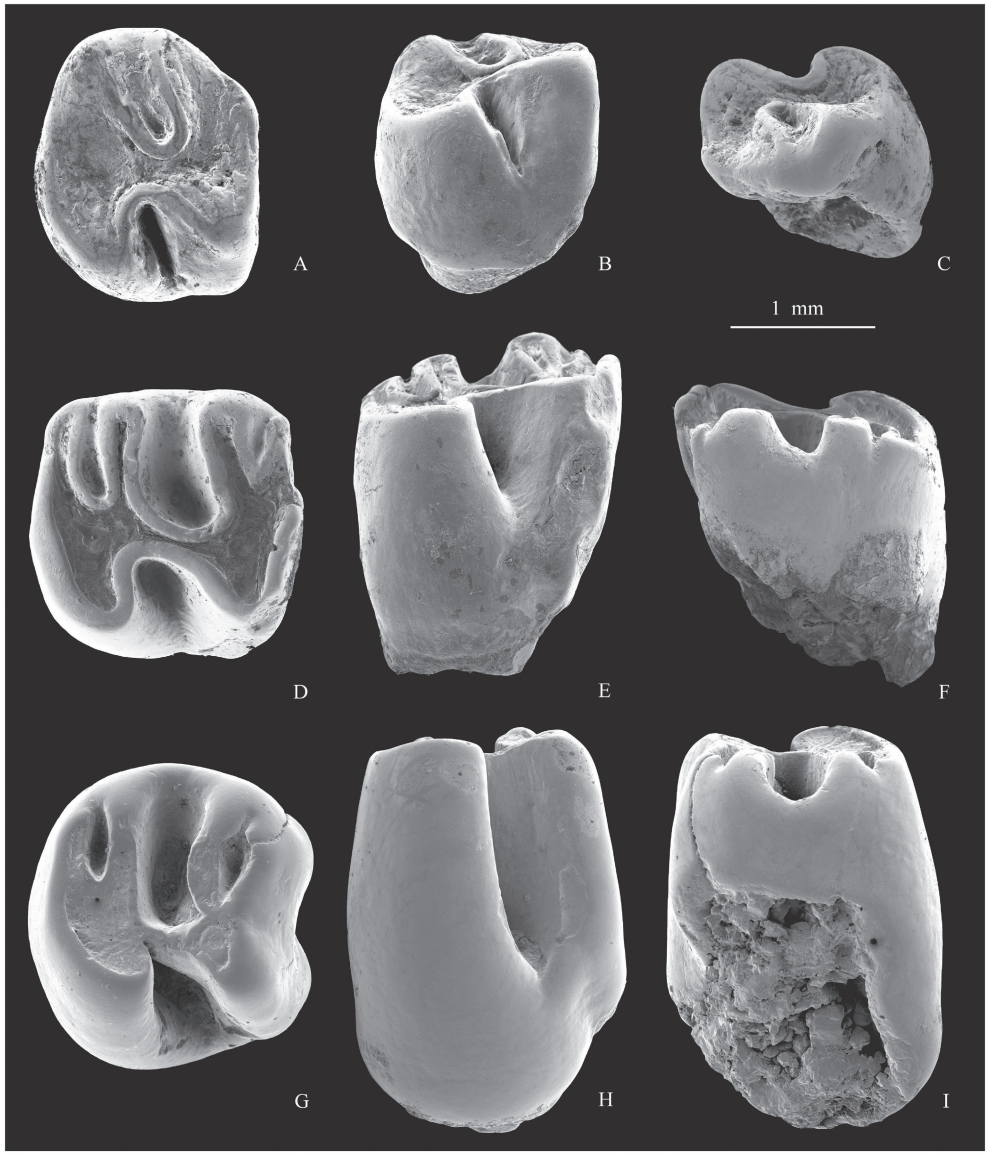

Fig. 1 Cheek teeth of *Sayimys sihongensis* sp. nov. from Sihong, Jiangsu
A–C. r DP4 (IVPP V 23216, reversed, paratype); D–F. l M1 (V 23215, holotype); G–I. r M3 (V 23217, reversed); A, D, G. in occlusal view; B, E, H. in lingual view; C, F, I. in buccal view

The M3 is more rounded in outline of the occlusal surface and larger in size than the M1. It is in an early stage of wear. The protocone and hypocone are connected by a short and straight endoloph. The paracone and metacone are confluent with the strong protoloph and metaloph, respectively. The protoloph is transverse and joins the posterior margin of the protocone. The metaloph is somewhat curved and bends backwards to join the hypocone. The anteroloph is slightly stronger than the posteroloph. They are connected with the paracone and metacone at the base to enclose the paraflexus and metaflexus, respectively. The paraflexus and metaflexus are developed and sub-equal in length, but the former is slightly deeper than the latter. Both the

hypoflexus and the mesoflexus are very deep with the hypoflexus extending across two-thirds of the crown. The hypoflexus is relatively narrower, with its internal area deeper than that of the mesoflexus, which is in turn much deeper than the paraflexus and metaflexus.

Comparison and discussion The occurrence of *Sayimys* in China has been known for seventy years since Bohlin (1946) described the ctenodactylid rodent from an Middle Miocene locality at Tiejianggou (Taben-Buluk area), in Gansu Province (Wang et al., 2008). Later, remains of the genus found in Ningxia and Jiangsu were reported (Li et al., 1983; Qiu and Qiu, 1995, 2013), but still no detailed study is available.

The three upper cheek teeth from Sihong, Jiangsu correspond to the diagnosis of *Sayimys* emended by Baskin (1996) in their moderate size, mesodonty, lophodonty, relatively quadrate outline of the occlusal surface, distinctly unilaterally high crown, having the hypocone size subequal to the protocone and anteriorly directed hypoflexus, and the development of paraflexus and metaflexus in molars. They show some similarities to the corresponding teeth of *Prosayimys* and *Metasayimys* in morphology, but differ from the former in higher crown, more lophate occlusal structure, and higher degree of unilateral hypsodonty, and from the latter in distinctly concave occlusal surface, more developed paraflexus and metaflexus, and the absence of cement on the crown. *Sayimys* is a genus of ctenodactylid rodents ranging from the Early Miocene to the Pliocene of Pakistan, India, Turkey, Saudi Arabia, Libya, Kazakhstan and China (Hinton, 1933; Wood, 1937; Bohlin, 1946; Black, 1972; Sen and Thomas, 1979; Munthe, 1980; De Bruijn et al., 1981, 1989; Wessels et al., 1982, 2003; Vasishat, 1985; Flynn and Jacobs, 1990; Baskin, 1996; De Bruijn, 1999; Kordikova and De Bruijn, 2001; López-Antoñanzas and Sen, 2003). Samples from most fossil localities are small, but several forms, *S. sivalensis* (Hinton, 1933), *S. perplexus* Wood, 1937, *S. obliquidens* Bohlin, 1946, *S. intermedius* (Sen and Thomas, 1979), *S. minor* De Bruijn et al., 1981, *S. badauni* Vasishat, 1985, *S. chinjiensis* Baskin, 1996, *S. baskini* López-Antoñanzas & Sen, 2003, *S. giganteus* López-Antoñanzas et al., 2004, and *S. assarrarensis* López-Antoñanzas et al., 2004 have been documented. I follow some researchers (Munthe, 1980; López-Antoñanzas et al., 2003, 2004a, b) in considering *Sayimys minor* as a junior synonym of *S. intermedius*, and *S. perplexus* and *S. chinjiensis* a junior synonym of *S. sivalensis*. Therefore I recognize the following seven species, *S. sivalensis*, *S. obliquidens*, *S. intermedius*, *S. badauni*, *S. baskini*, *S. assarrarensis* and *S. giganteus*. The above described specimens (from the Xiacaowan Formation of Early Miocene age, Sihong, Jiangsu Province, China) demonstrate characters different from all known species of *Sayimys*, and are considered to represent a new species of the genus.

In the new species *Sayimys sihongensis*, the M1 is close to that of *S. sivalensis* in size, but falls into the low end of size variation (see López-Antoñanzas et al., 2004a). Morphologically, in the Sihong species, the paraflexus and metaflexus on DP4 are more quickly obliterated with wear than those in *S. sivalensis*. The paraflexus on M1 is longer than the metaflexus, whereas in *S. sivalensis* it is usually shorter than the metaflexus. Were an *S. sivalensis* M1 to reach such a wear stage as the Sihong specimen, the paraflexus would be absent. In addition, the paraflexus and metaflexus on M3 are distinctly more developed than in *S. sivalensis*.

The new species is smaller than *S. obliquidens*, and morphologically differs from it in having a deeper paraflexus and metaflexus on M1 than in *S. obliquidens*, so obliterate more slowly. The hypoflexus on M1 of the Sihong species is wider than that of *S. obliquidens*, and the paraflexus and metaflexus on M3 are narrower, but the mesoflexus is wider than in *S. obliquidens*. In additional, the mesoflexus on the M3 is nearly transverse, and less anteriorly oriented.

Sayimys sihongensis is smaller than *S. intermedius* in size. It has a more quickly obliterated paraflexus and metaflexus on DP4 with wear than the latter. In the new species, the anterior side of M1 is nearly as wide as the posterior side, while it is distinctly wider than the posterior side in *S. intermedius*. The hypocone on M1 is slightly larger than the protocone, whereas it is smaller than the protocone in *S. intermedius*. The M1 shows the hypoflexus deeper (more persistent along the crown) than the mesoflexus, whereas in the upper molar of *S. intermedius*, the hypoflexus is nearly as deep as the mesoflexus. In addition, the metaloph on M1 is more transverse and straight in *S. sihongensis* than in *S. intermedius*. The mesoflexus on M3 is narrower and more extended lingually than in *S. intermedius*.

Remains of *Sayimys badauni* are known only from the Pliocene Tatrot Formation, in India (Vasishat, 1985). All the upper molars show a pattern of two lophs, with the anterior loph larger than the posterior one. In addition to the morphological differences, *S. badauni* is characterized by its larger size than *S. sihongensis*. Obviously, the taxon from the Upper Siwaliks represents a relatively derived species of the genus.

Sayimys sihongensis has the hypocone on DP4 slightly external to the protocone, whereas in *S. baskini*, it is slightly internal to the protocone. Paraflexus and metaflexus on this tooth are more quickly obliterated with wear, while those in *S. baskini* are developed and deep (see López-Antoñanzas and Sen, 2003).

Sayimys sihongensis differs from *S. assarrarensis* in slightly smaller size, but having higher crowned cheek teeth and longer and more prominent paraflexus and metaflexus on the upper molars.

Comparison with *Sayimys giganteus* shows that size of *S. sihongensis* is distinctly smaller. In morphology, the new taxon has buccally protruding paracone and metacone, more quickly obliterated paraflexus and metaflexus with wear, and wider hypoflexus but narrower mesoflexus on DP4, more transverse and straight protoloph and metaloph, and wider hypoflexus on M1, and narrower but more lingually extended paraflexus and metaflexus on M3.

The teeth described above are considered to be sufficiently different from all known species of the genus to warrant the erection of a new species, despite the limited material. The occurrence of ctenodactylids in eastern China improves our knowledge of their spatial distribution. The new species represents the eastern extension of *Sayimys*. It contributes to a better understanding of the paleobiogeographic relationships between northern Africa and the Far East.

Family Eomyidae Deperet & Douxhami, 1902
Subfamily Apeomyinae Fejfar et al., 1998
Genus *Apeomys* Fahlbusch, 1968

Type species *Apeomys tuerkheimae* Fahlbusch, 1968.

Diagnosis See the emended diagnosis by Fejfar and others (1998:126).

Apeomys asiaticus sp. nov.

(Fig. 2)

Apeomys sp.: Qiu and Qiu, 2013, p. 147

Etymology Asia, in Latin – geographic name, indicating the first record in Asia.

Holotype Right P4 (IVPP V 23218, from Zhengji, Sihong, Jiangsu Province).

Type locality Zhengji, Sihong, Jiangsu Provice.

Geological age and horizon Late Early Miocene, Shanwangian; Xiacaowan Formation.

Measurements 1.05 mm×1.25 mm.

Diagnosis Relatively large species of *Apeomys*. P4 with anteroloph fused with protoloph, syncline I lacking or obliterated in the early stage of wear, mesoloph absent, and syncline II+III closed lingually.

Description The holotype is interpreted as a P4, because of the presence of an inner root and no sign of wear facet on its anterior side. It is rather high crowned (for an eomyid) and somewhat unilaterally hypsodont, with the lingual side slightly higher than the buccal side. The occlusal outline is subquadrate, with buccal side somewhat longer than the lingual side. The occlusal surface is slightly concave. The P4 is moderately worn. The crown consists of two lobes divided by a deep transverse valley (syncline II+III). The anterior lobe, actually a thick ridge representing a fused anteroloph and protoloph, is stronger than the posterior one. The posterior lobe is composed of the metaloph, the posteroloph and an oval basin between (syncline IV). The anterior lobe is almost as wide as the posterior lobe, but longer than the posterior one. The two lobes are lingually connected by an enamel isthmus. The syncline I is

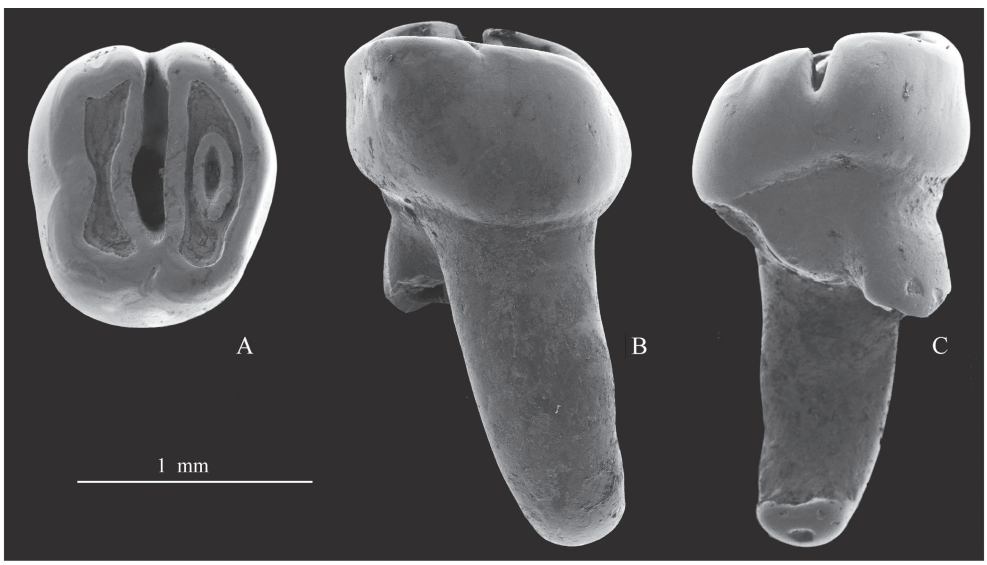

Fig. 2 Right P4 of *Apeomys asiaticus* sp. nov. from Sihong, Jiangsu (IVPP V 23218, holotype)
A. in occlusal view (reversed); B. in lingual view; C. in buccal view

either lost or obliterated. The syncline II+III is deep and lingually closed, but the presence of a small notch in the lingual border between the two lobes seems to suggest early lingual opening of the synclines II+III in unworn stage. The syncline IV is laterally closed as an oval enamel lake. The enamel is thick. The tooth has three roots: one mesial-distally elongated lingual root, and two buccal roots.

Comparison and discussion The specimen described was collected by washing concentrate of a fossiliferous layer at Zhengji, a late Early Miocene locality at Sihong, Jiangsu Provence in 1994. Along with the specimen are remains of *Diatomys*, *Sayimys*, *Heterotamias*, *Plesiosciurus*, *Democricetodon*, *Megacricetodon*, *Neocometes*, and others (Qiu, 2010, 2015; Qiu and Qiu, 2013; the present paper). The tooth was first recognized by B. Engesser and O. Fejfar as an indeterminate species of *Apeomys* when they visited the IVPP in 1996 (but not published). There seems to be no doubt that the P4 belongs to an *Apeomys*-like eomyid, because of the relatively small size, the lophate transverse crests with narrow valleys, the slightly concave occlusal surface, the more or less unilaterally hypsodont crown, the lack of entoloph, the presence of two lobes separated by a deep valley, and the oval structure with an oval basin on the posterior lobe.

The genera *Apeomys* and *Megapeomys* are assigned to a subfamily Apeomyinae in Eomyidae (Fejfar et al., 1998). Apeomyines represent an aberrant group of eomyids, with short history (ranging from the Late Oligocene–Early Miocene) and rare record but a wide paleogeographic distribution in Eurasia and North America. In Europe, they are mainly recorded in karstic fillings with one or two species of each genus (*A. tuerkheimae* from MP30 and MN1, and *M. lavocati* and *M. lindsayi* from MN3–4). In Asia one species, *M. repenningi*, is represented by only one m1 from the Early Miocene of Dota, Japan (Tomida, 2011) and the new species, *A. asiaticus*, from Sihong, China described here. Two genera and species from the Miocene of Nevada, North America, *M. bobwilsoni* of Hemingfordian, Early Miocene age (Morea and Korth, 2002), and *Apeomyoides savagei* of Middle Miocene Barstovian age (Smith et al., 2006) can also be grouped in the subfamily, although they show some distinct differences from Eurasian species in size and morphology (i.e. larger size, higher crowned cheek teeth, P4 and p4 being the biggest cheek teeth, presence of an incomplete or complete entoloph in M1/2, etc).

The Eurasia *Megapeomys*, with relatively larger size and derived morphology, is considered to be a descendant of *Apeomys* (Engesser, 1999). Although there is no specimen available for a direct comparison, the P4 from Sihong cannot be referred to *Megapeomys* because of the distinctly smaller size. It is comparable to other *Apeomys* in size and morphology (Fahlbusch, 1968). *Apeomys* in Europe includes *A. tuerkheimae* from MP30–MN1/2 faunas and *Apeomys* cf. *A. tuerkheimae* from MN3–4 faunas (Fejfar et al., 1998). The differences between the Sihong P4 and that of *A. tuerkheimae* are: 1) the anteroloph and protoloph are incompletely fused in *A. tuerkheimae*, but completely fused in the Sihong taxon; 2) there is a buccally opened syncline I in *A. tuerkheimae*, but the syncline is missing or disappears in early wear in the Sihong taxon; 3) a short mesoloph or its remnant is present

in *A. tuerkheimae*, but it is absent in the Sihong taxon; 4) a lingual connection of the anterior lobe and the posterior lobe is present in the Sihong taxon, but the connection is absent in *A. tuerkheimae*. In comparison with the P4 of *Apeomys* cf. *A. tuerkheimae* (see Fahlbusch, 1968:fig. 8b), the Sihong P4 is similar to the tooth of the European species in their similar size and the loss of mesoloph, but differs in the anteroloph completely fused with the protoloph, the loss or disappearance of syncline I in the early stage of wear, and the presence of a lingual connection between the two lobes. Therefore, in view of the morphologic differences and its occurrence in Asia, the P4 from Sihong is treated as a new species of the genus *Apeomys*, despite the scarcity of currently known material. A possibility of the specimen belonging to a new genus of the Apeomyinae cannot be precluded, due to the lingually closed syncline II+III on the tooth, which is a feature not present in the European *Apeomys*. Nevertheless, either improved knowledge of the new species or establishment of a new genus for the taxon should await the discovery of more material.

The P4 from Sihong represents the first record of *Apeomys* from Asia. The origin and migration of the new species is not clear, but it may be an immigrant from Europe. *A. asiaticus* is possibly a relatively advanced *Apeomys*, which is apparently more derived than *A. tuerkheimae*, particularly in the loss of mesoloph on P4. The incorporation of anteroloph and protoloph, the absence of mesoloph, and the presence of lingual connection between the two lobes on P4 are here interpreted as advanced characters for the new species. In apeomyines there seems to exist the general evolutionary trend to enlarge the size of teeth, lose syncline I and the mesoloph in P4.

Subfamily Eomyinae Winge, 1887

Genus *Yuneomys* gen. nov.

Type species *Yuneomys pusillus* (Qiu, 2006) = *Leptodontomys pusillus* Qiu, 2006.

Etymology Yun, the abbreviated form of Yunnan Province; *Eomys*, a genus of Eomyidae with bunodont cheek teeth; referring the first occurrence of the new eomyid genus in Yunnan, China.

Diagnosis Small-sized eomyids with bunodont cheek teeth. M1 and M2 with poorly developed lingual anteroloph, short mesoloph, complete entoloph, nearly transverse sinus, and transversely long syncline IIs and IVs surpassing midline of tooth; m1 and m2 with small mesoconid, narrow anterolophid and posterolophid, complete ectolophid, wide sinuid, broad synclinid Isd and IVsd, and usually anteriorly directed hypolophid joining hypoconid or anterior arm of hypoconid.

Differential diagnosis The new genus *Yuneomys* is characterized by its small size and bunodont cheek teeth, and is closely similar to the genus *Leptodontomys* Shotwell, 1956 and to *Eomyops* Engesser, 1979 in size and morphology. It is easily distinguished from all eomyids with lophodonty by the bunodont tooth pattern, and differs from most bunodont forms in relatively small dimensions. Main differences of the new genus from those taxa with bunodont teeth are as follows.

Yuneomys differs from *Eomys* Schlosser, 1884 in having more lingual extension of the Is,

IIs and IVs in M1 and M2, less buccal extension of the IIIsd in m1 and m2, and its anteriorly directed hypolophid joining the hypoconid or the anterior arm of hypoconid in p4–m2.

Yuneomys differs from North American *Leptodontomys* Shotwell, 1956 and European *Eomyops* Engesser, 1979 in having poorly developed lingual anteroloph in M1 and M2 and narrower anterolophid and posterolophid in m1 and m2, and in the hypolophid being anteriorly directed and buccally connected with the hypoconid or the anterior arm of hypoconid in p4–m2.

Yuneomys differs from *Pentabuneomys* Engesser, 1990 in smaller size, narrower lingual anteroloph in M1 and M2 and narrower anterolophid and posterolophid in m1 and m2, more lingual extension of Is and IVs in M1 and M2, and in the hypolophid being anteriorly directed and buccally connected with the hypoconid or the anterior arm of hypoconid in p4–m2.

Yuneomys differs from *Plesieomys* Qiu, 2006 in smaller size, having relatively distinct lingual anteroloph, lacking an enlarged end of mesoloph in M1 and M2, and having relatively complete hypolophid in p4–m2.

Yuneomys differs from *Heteroeomys* Qiu, 2006 in smaller size, having a weak lingual anteroloph and more lingual extension of Is and IVs in M1 and M2, and a relatively complete, anteriorly directed hypolophid in p4–m2.

Yuneomys differs from *Pseudadjidaumo* Lindsay, 1972 in having a weaker development of lingual anteroloph in M1 and M2, and the transverse loph(id)s directed more perpendicular to the longitudinal axis in molars.

Yuneomys differs from *Ronquillomys* Jacobs, 1977 in smaller size, having a deeper Is in M1 and M2, more distinct anterolophid and broader IVsd in m1 and m2, and the entoloph situated more lingually in M1 and M2, and ectolophid more buccally in m1 and m2.

Yuneomys differs from *Kansasimys* Wood, 1936 in smaller size, having a developed anterolophid and an anteriorly directed hypolophid in m1 and m2.

***Yuneomys pusillus* (Qiu, 2006)**

(Fig. 3)

Leptodontomys sp. nov.: Qiu et al., 1985, p. 19 [partim]

Leptodontomys sp. nov. 1: Qiu, 1994, p. 51

Leptodontomys pusillus: Qiu, 2006, p. 315

Holotype A right M1/2 (0.70 mm×0.80 mm); IVPP V 14732.

Type locality Shihuiba, Lufeng County, Yunnan Province.

Stratum typicum Layer 6, Shihuiba Formation, early Baodean, Late Miocene.

Paratypes Four isolated teeth: 2 P4 (0.70 mm×0.75 mm, 0.70 mm×0.80 mm), 1 p4 (0.65 mm×0.60 mm), 1 m1/2 (0.75 mm×0.70 mm). IVPP V 14733.3–6.

Referred specimens Layer 5 – 1 M1/2 (0.65 mm×0.75 mm), 1 m1/2 (0.70 mm×0.70 mm). IVPP V 14733.1–2.

Diagnosis Same as for the genus.

Description The cheek teeth are bunodont with four nearly equally developed main cusps. The cusps are more striking than the crests.

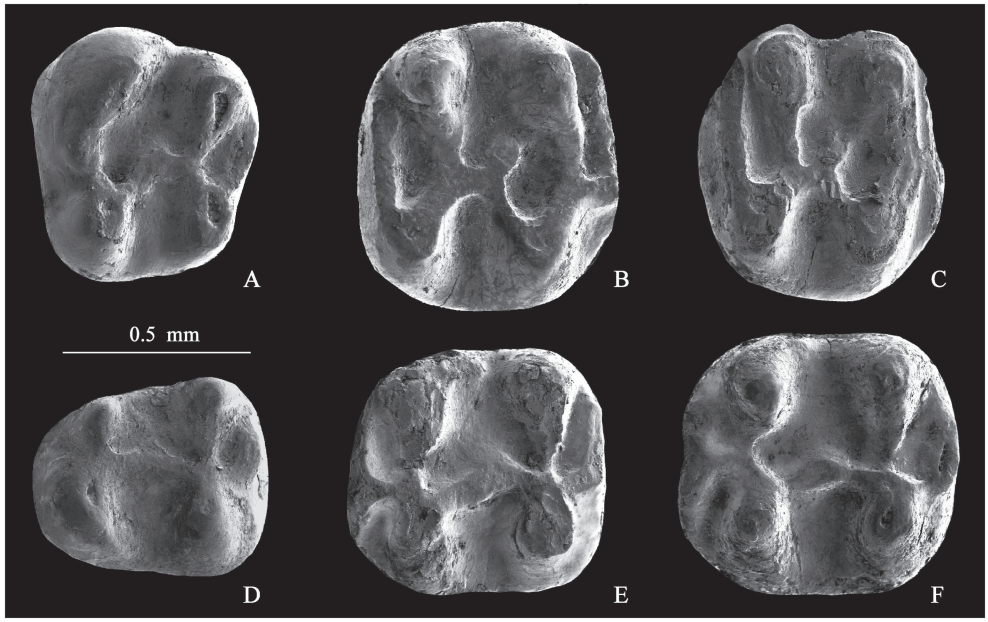

Fig. 3 Cheek teeth of *Yuneomys pusillus* from Lufeng, Yunnan in occlusal views
A. l P4 (IVPP V 14733.4); B. r M1/2 (V 14732, holotype, reversed); C. r M1/2 (V 14733.1, reversed); D. l p4 (V 14733.5); E. l m1/2 (V 14733.2); F. l m1/2 (V 14733.6)

The P4 is trapezoidal in occlusal outline, with a wider anterior portion than posterior portion and the buccal side longer than the lingual one. A remnant of anteroloph and a short mesoloph directed slightly anteriorly are seen in one of the two teeth. The entoloph is short and curved, but distinct. The posteroloph is thin, joining the hypocone directly. The IIs and IVs are deep and wide.

The M1/2 is sub-quadrate in occlusal outline with perfectly rounded corners. A pronounced anteroloph is present, but its lingual part is poorly developed. The protoloph and metaloph are nearly perpendicular to the entoloph. The entoloph, situated lingual to the midline of the tooth, is strong and curved. The mesoloph is short, but distinct and directed toward the paracone. The lingual syncline is relatively wide and nearly transverse. The IIs and IVs extend lingually past the midline of the tooth.

The p4 is longer than wide, and distinctly narrower anteriorly than posteriorly due to the relatively weakly developed metaconid. An anterolophid is missing. There is a low connection between the protoconid and metaconid. A mesolophid is indistinct. The ectolophid is low, but continuous. The posterolophid is weakly developed.

The m1/2 is sub-quadrate in occlusal outline. The anterolophid is distinct, but short transversely, connected with the metalophid by a thick crest. The ectolophid, situated buccal to the midline of the tooth, is prominent, with the anterior portion slightly anterobuccally directed. The mesolophid is indistinct. The hypolophid is anteriorly directed and weakly joining the hypoconid or the anterior arm of hypoconid. The posterolophid is narrow and joins the hypoconid nearly at a right angle. The buccal syncline is very wide. The Isd and IVsd are broad, and the IIsd extends buccally past the midline of the tooth.

Comparison and discussion The described specimens from the Late Miocene Shihuiba Formation of Lufeng, Yunnan were first referred to the genus *Leptodontomys* (Qiu et al., 1985; Qiu, 1994, 2006). They show strong similarities to *Leptodontomys* and *Eomyops* in size, and in having opposite arrangement of main cusps, short mesoloph, lingual anteroloph and the IIs and IVs extending lingually past the midline of teeth on M1 and M2, and well developed IVsd on m1 and m2. However, these teeth are different from those of all known species of *Leptodontomys* or *Eomyops* in having distinctly weaker development of the lingual anteroloph on M1 and M2, and narrower anterolophid and posterolophid, poorly developed mesolophid and the anteriorly directed hypolophid connected with the hypoconid or the anterior arm of hypoconid on m1 and m2. These differences seem to be indicative of a different generic status for the Lufeng eomyid, which is proposed to define a new genus.

Distinct differentiation in distribution of mammals between North and South China is considered to have developed in the Miocene Epoch (Qiu and Li, 2005). Among fossil small mammals for example, many representatives now living in the Oriental Region or mainly in tropical-subtropical zones, such as Tupaiidae, Echinosoricinae, Pteropidae, Platacanthomyidae, Rhizomyidae and Hystricidae, occur in the Late Miocene Yuanmou and Lufeng faunas in southern China, whereas those restricted to or mainly distributed over the Holarctic or Palaearctic Region, such as Aplodontidae, Gliridae, Zapodidae, Dipodidae and Ochotonidae, are found in the coeval Amuwusu, Shala, Baogeda Ula and Ertemte faunas in northern China. It is to be noted that the new genus *Yuneomys* coexists with *Plesieomys* and *Heteroeomys* in the Lufeng Fauna, and none of these eomyid genera is found in the north. *Ligerimys*, *Asianeomys*, *Keramidomys*, *Leptodontomys* and *Pentabuneomys*, in contrast, are known from the Miocene faunas in the north. In addition, all three forms of eomyids found in Yunnan show bunodont cheek teeth, while lophodont species are rather commonly known in the north. The pattern of occurrence in faunal assemblages and the contrasting morphological features of the taxa seem to indicate difference in paleoecology between North and South China during the Late Miocene. The association of bunodont eomyids in Yunnan most probably indicates wet forest habitats, whereas the occurrence of lophodont eomyids in northern faunas would correspond to drier steppe environment. Miocene differentiation of eomyid faunas in the northern and southern parts of China may reflect ecological partitioning within southeastern Asia. Such an occurrence of eomyids in Yunnan seems to provide further evidence to support the conclusion that the Oriental Region already existed in the Miocene as suggested by Qiu and Li in 2005.

Family Platacanthomyidae Alston, 1876

Genus *Neocometes* Schaub & Zapfe, 1953

Neocometes sp.

(Fig. 4)

Neocometes sp.: Qiu and Qiu, 1995, p. 61
Neocometes sp.: Qiu and Qiu, 2013, p. 147

Material One m3 (IVPP V 23219, from Zhengji, Sihong, Jiangsu Province).

Geological age and horizon Late Early Miocene; Shanwangian, Xiacaowan Formation.

Measurements 1.85 mm×1.45 mm.

Description The specimen described is determined as an m3 because of its distinct posterior constriction due to the reduce of entoconid and posterolophid. In addition, no sign of a wear facet can be seen on the posterior wall of the tooth. The m3, in early stage of wear, is moderately high crowned and subrectangular, with nearly flattened grinding surface, straight anterior margin, rounded posterior margin and nearly parallel lateral margins. The tooth consists of six diagonal/transverse ridges separated by five narrow synclines. The anterolophid is complete and straight, extending from the paraconid to the anterointernal corner of the tooth. The anterior extra ridge is quite developed, directing anterobuccal-posterolingually, connecting with the anterolophid buccally, and being free lingually. The paralophid is thick and straight, and slightly constricted at the contact with the paraconid buccally and the entolophid lingually. The mesolophid is roughly parallel to the paralophid, with the buccal portion thicker than the lingual one, and angled posterolingually at about 80° to the longitudinal axis. The hypolophid is directed slightly backwards. It is shorter than the mesolophid, and has a free lingual end as does the mesolophid. The posterolophid is short but distinct, originating from the hypolophid, buccal to the midline of the tooth and extending to the base of the entoconid lingually. A weak entolophid is developed at this stage of wear, but a continuous entolophid would appear with advanced wear of the tooth. The syncline Ia is small, narrow and located anterolingually on the tooth, and joins the syncline I lingually. The syncline I is long and laterally closed. It is more marked than the syncline Ia. Syncline II, the longest syncline of the tooth, is parallel to the syncline I. It is lingually closed and buccally opened, deeply extending to the base of the crown at the external area. The syncline III is similar to, but shorter and narrower than the syncline II. The syncline IV is small, but larger than the syncline Ia. It is situated at the posterolingual part of the tooth as an elongated and curved basin.

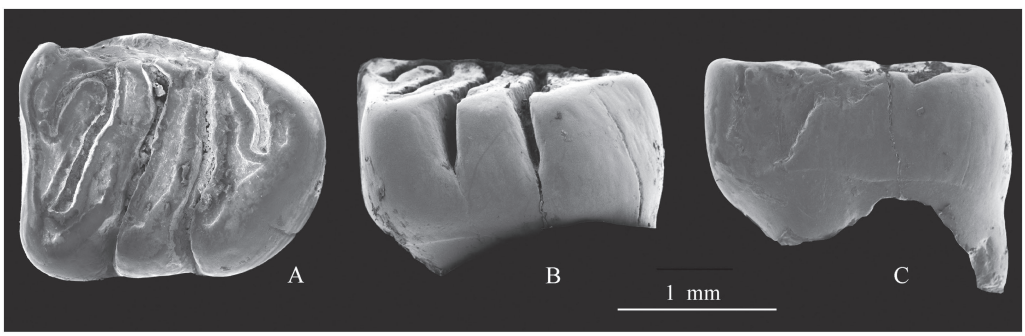

Fig. 4 Left m3 of *Neocometes* sp. from Sihong, Jiangsu (IVPP V 23219)
A. in occlusal view; B. in lingual view; C. in buccal view

Comparison and discussion Remains of the genus *Neocometes* Schaub & Zapfe, 1953 were first discovered in Europe. The occurrence of the only known fossil genus of platacanthomyids in Europe ranged from middle Orleanian to the end of Astaracian, spanning about 7 Ma (from late Early Miocene to late Middle Miocene). Record of *Neocometes* in Asia

is rather poor, which was not recognized until the end of last century by several isolated teeth from Thailand (Mein et al., 1990). The described specimen, an m3 from the late Early Miocene Xiacaowan Formation in Sihong, Jiangsu Province, represents so far the only known remains of *Neocometes* in China. The specimen was reported by Qiu and Qiu (1995), but has not been described in detail. Recently, an m1, representing the third record in Asia, was described (as *Neocometes* aff. *N. similis*) from the Bukpyeong Formation (Early Miocene/Middle Miocene) in South Korea (Lee and Jacobs, 2010).

The m3 exhibits characters that are highly diagnostic for *Neocometes* by its lophodonty with six diagonal/transverse ridges separated by five synclines, the less inclined ridges/synclines, and the buccal closing of syncline IV. By these characters, it can be distinguished from the m3 of *Typhlomys* and *Platacanthomys* in the family Platacanthomyidae.

Although *Neocometes* is never very frequent in the fossil record, it has a wide geographical distribution during the Miocene. Three species of the genus have been defined in Eurasia, i.e. *N. orientalis* from Thailand, and *N. similis* and *N. brunonis* from Europe (Schaub and Zapfe, 1953; Fahlbusch, 1966; Fejfar, 1974, 1999; Mein et al., 1990). *N. orientalis* is considered to be the oldest and most primitive species of the genus. The described specimen cannot be directly comparable with *N. orientalis* and *Neocometes* aff. *N. similis* because of lack of m3 in the Thailand and South Korea material. Nevertheless, judging from the size and morphology of the m3, the Chinese form would be larger in size, and differ from *N. orientalis* in having stronger ridges and narrower synclines in morphology. It is also larger than *N. similis*. In addition, in the European species the m3 usually displays more reduction, with the posterior portion being more contracted, the syncline Ia and IV smaller or absent. The m3 is close to that of *N. brunonis* in size, but differs in showing a tendency to close all lingual synclines, and in being less reduced (with complete ridges and distinctly marked synclines Ia and IV). More material may testify that the Chinese taxon represents a new species of *Neocometes*.

3 Concluding remarks

Sayimys, *Apeomys*, *Yuneomys* and *Neocometes* are poorly known rodents in Chinese Neogene assemblages of small mammals. Among the described materials, the P4 of *Apeomys* and the m3 of *Neocometes* from the Early Miocene Xiacaowan Formation of Sihong, Jiangsu Province represent the first records of the genera in Asia or in China, respectively.

Detailed descriptions of the materials show that the specimens of *Sayimys* and *Apeomys* connot be referred to any known species of the genera, and are therefore assigned to two new species, *S. sihongensis* and *A. asiaticus*. The Sihong specimens represent the easternmost occurrence of *Sayimys* and *Apeomys* in the Old World.

Yuneomys is a new genus defined on the basis of the material previously referred to *Leptodontomys pusillus* from the Late Miocene Shihuiba Formation of Lufeng, Yunnan Province. The bunodont cheek teeth and the association of hominoids and abundant tropical

or subtropical elements, including hylomyines and platacanthomyines in the Shihuiba fauna, imply that *Yuneomys* were tropical or subtropical dwellers. The joint occurrence of *Yuneomys* with bunodont eomyids *Plesieomys* and *Heteroeomys* and the absence of lophodont eomyids in the Lufeng Fauna seem to indicate differences in paleoecology between North and South China during the Late Miocene. Miocene differentiation of eomyid faunas in the northern and southern parts of China may reflect ecological partitioning within southeastern Asia.

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中国新近纪几种稀有啮齿动物

邱铸鼎

(中国科学院古脊椎动物与古人类研究所 北京 100044)

摘要：30多年来，中国新近纪堆积物中发现了大量的小哺乳动物化石，但一些种类的材料很少，而且仅在个别地点出现，在动物群中常以未定属、种记述。详细描述了4种罕见的啮齿动物，其中3种，泗洪豪鼠(*Sayimys sihongensis*)、亚洲别齿始鼠(*Apeomys asiaticus*)和新来鼠(未定种) (*Neocometes* sp.)发现于江苏泗洪早中新世下草湾组，一种，细小云南始鼠(*Yuneomys pusillus*)产自云南禄丰晚中新世石灰坝组。与欧亚或北美有关材料的比较研究表明，江苏泗洪标本无法归入相关属的任何已知种，因此被确定了两个新种(*S. sihongensis*和*A. asiaticus*); 禄丰原归入*Leptodontomys pusillus*的标本与该属的特征不符，被指定为新属*Ynueomys*。泗洪的*A. asiaticus*和*Neocometes* sp.分别代表该属在亚洲和中国的首次记录；它们与*S. sihongensis*在亚洲远东地区的出现，增加了我们对这些稀有动物地理分布和欧亚古生物地理关系的知识。禄丰的新属*Yuneomys*与共生的*Plesieomys*和*Heteroeomys*属同为丘齿型始鼠类，可能都属热带或亚热带森林型动物；在禄丰动物群中缺少脊齿型始鼠类，与华北动物群的组成不同，似乎表明华南和华北始鼠动物群在中新世期间已有明显的分异，进而支持这一时期亚洲出现了不同生态区系的设想。

关键词：泗洪，禄丰，中新世，下草湾组，石灰坝组，啮齿动物

中图法分类号：Q915.873 **文献标识码**：A **文章标号**：1000–3118(2017)02–0092–18

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